

Correlation Analysis Between Pork Price and Beef Price

Xintian Lin

School of Accounting, Shanghai University of International Business and Economics, Shanghai 201620, China.

Abstract: Pork occupies a significant proportion in the consumption structure of our daily life and is the main consumer goods. The quality and safety of pork relates to people's health and basic consumption safety, as well as the stability of the food market and the competitive position in international trade. In recent years, consumers have expressed concerns about the quality and safety of livestock products in the face of the mad cow disease, swine bird flu and foot-and-mouth disease, and many economists say that changes in pork prices could influence the entire Chinese economy. Therefore, this paper collected 31 groups of data from China pork network and price trend network, and published and collected 91 online questionnaires. It conducted Contingency Analysis, Analysis of Variance, and Regression Analysis on pork prices and beef prices to verify the relationship between pork prices and beef prices, and to test the impact of pork prices on beef prices, so as to draw conclusions and put forward corresponding policy recommendations. *Keywords:* Pork Price; Beef Price; Contingency Analysis; Analysis of Variance; Regression Analysis

1. Introduction

At the beginning of 2022, some media reported that the price of pork in China was impacted, and it may decline in a short time. Based on 31 groups of data from China Pig Breeding Network and Price Trend Network, as well as 91 online questionnaires released and collected, this paper conducts contingency analysis, variance analysis, and regression analysis on pork price and beef price to verify the relationship between pork price and beef price, and test the impact of pork price on beef price, so as to draw conclusions and put forward corresponding policy recommendations.

2. Manuscript Preparation

2.1 Summary of related concepts

In this paper, the fluctuation of pork price is used to explore its impact on the fluctuation of beef price. The reason why pork is selected as the independent variable for analysis is that pork has an unshakable status in China. First of all, for the Chinese economy, China is not only a big pig producer but also a big pork consumer. Therefore, pork can effectively drive China's GDP growth.

Changes in the price of pork will also lead to changes in the price of other commodity prices, thus affecting the change of CPI. National consumer price index (CPI) rose 2.1 percent year on year in April, the second consecutive month of growth, according to data released by the National Bureau of Statistics on May 11. Producer price index (PPI) growth continued to fall as expected. However, the core CPI, which excludes food and energy prices, was stable and fell to a 10-month low over the same period, suggesting a structural contradiction in current inflation.

Finally, pork also represents a strong touch of color in Chinese culture. On January 11, 2021, Anyou Group launched a live broadcast around the "Global VR Press Conference -- Chinese 'Pig' Culture Popularization Course". The chairman of Anyou Group, Professor Hong Ping and Professor Zhang Weili, gave an online lecture, from the contribution of pigs to human beings and the history and culture of pork, leading everyone to understand different "pigs"! It is hoped that through this press conference, the people can better understand, love and get close to pigs, and jointly create a more prosperous and beautiful future.

In a word, pork is vital to China's economic, cultural and long-term development, which is the main core of this paper.

2.2 Data sources

This paper selects the monthly wholesale price data (RMB/kg) from December 2021 to May 2022 for a total of 6 months. Combined with the demand for meat products in Chinese residents' consumption habits, this paper selects beef as a substitute for pork and analyzes the relationship between pork price fluctuations and beef price fluctuations in 2022.

2021.12.01 24.61 77.62 2021.12.18 23.87 75.00 2021.12.25 23.28 71.23 2022.01.01 22.93 67.00 2022.01.14 22.26 89.00 2022.01.25 21.97 83.12 2022.02.01 21.61 72.34 2022.02.02 21.29 71.00 2022.02.09 21.29 71.00 2022.02.09 21.29 71.00 2022.02.09 21.29 71.00 2022.02.09 21.29 71.00 2022.02.01 18.66 72.13 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.08 18.32 71.00 2022.03.25 18.22 72.41 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.10 17.95 71.60 <th>Date</th> <th>Pork price (RMB/kg)</th> <th>Beef price (RMB/kg)</th>	Date	Pork price (RMB/kg)	Beef price (RMB/kg)
2021.12.18 23.87 75.00 2021.12.25 23.28 71.23 2022.01.01 22.93 67.00 2022.01.14 22.26 89.00 2022.01.20 21.81 87.32 2022.01.25 21.97 83.12 2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.17 19.97 70.00 2022.03.01 18.66 72.13 2022.03.03 18.32 71.11 2022.03.04 18.32 71.11 2022.03.05 18.22 72.41 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.10 17.95 73.20 2022.04.11 18.40 71.73 2022.04.12 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 <td>2021.12.01</td> <td>24.61</td> <td>77.62</td>	2021.12.01	24.61	77.62
2021.12.25 23.28 71.23 2022.01.01 22.93 67.00 2022.01.14 22.26 89.00 2022.01.20 21.81 87.32 2022.01.25 21.97 83.12 2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.17 19.97 70.00 2022.02.3 18.96 71.99 2022.03.01 18.66 72.13 2022.03.02 17.99 71.00 2022.03.03 18.32 71.11 2022.03.04 18.22 72.41 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.05 18.30 71.60 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.05.01 20.21 75.16 2022.05.12 20.26 76.49 2022.05.12 20.27 76.46	2021.12.18	23.87	75.00
2022.01.01 22.93 67.00 2022.01.14 22.26 89.00 2022.01.20 21.81 87.32 2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.01 19.97 70.00 2022.02.17 19.97 70.00 2022.02.23 18.96 71.09 2022.03.01 18.66 72.13 2022.03.02 17.99 71.00 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.11 18.40 71.73 2022.05.01 20.21 75.16 2022.05.12 20.26 76.49 2022.05.15 20.98 77.12 <td>2021.12.25</td> <td>23.28</td> <td>71.23</td>	2021.12.25	23.28	71.23
2022.01.14 22.26 89.00 2022.01.20 21.81 87.32 2022.01.25 21.97 83.12 2022.02.00 21.61 72.34 2022.02.09 21.29 71.00 2022.02.09 21.29 71.00 2022.02.09 21.29 71.00 2022.02.01 19.97 70.00 2022.02.02 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.16 18.07 70.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.40 71.73 2022.05.01 20.21 75.16 2022.05.02 20.35 76.49 2022.05.15 20.39 76.88 <td>2022.01.01</td> <td>22.93</td> <td>67.00</td>	2022.01.01	22.93	67.00
2022.01.20 21.81 87.32 2022.01.25 21.97 83.12 2022.02.00 21.61 72.34 2022.02.09 21.29 71.00 2022.02.01 19.97 70.00 2022.02.02 18.96 71.09 2022.02.03 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.05.01 20.21 75.16 2022.05.01 20.21 75.16 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.25 20.39 76.88 <td>2022.01.14</td> <td>22.26</td> <td>89.00</td>	2022.01.14	22.26	89.00
2022.01.25 21.97 83.12 2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.17 19.97 70.00 2022.02.23 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.15 18.40 71.73 2022.04.15 18.40 71.73 2022.05.01 20.21 75.16 2022.05.10 20.21 75.16 2022.05.10 20.14 76.04 2022.05.15 20.98 77.12 <td>2022.01.20</td> <td>21.81</td> <td>87.32</td>	2022.01.20	21.81	87.32
2022.02.01 21.61 72.34 2022.02.09 21.29 71.00 2022.02.17 19.97 70.00 2022.02.23 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.08 18.32 71.00 2022.03.08 18.32 71.00 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.01 20.26 76.49 2022.05.10 20.14 76.04 2022.05.15 20.98 77.12 2022.05.15 20.39 76.88 <td>2022.01.25</td> <td>21.97</td> <td>83.12</td>	2022.01.25	21.97	83.12
1000000000000000000000000000000000000	2022.02.01	21.61	72.34
2022.02.17 19.97 70.00 2022.02.23 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.08 18.32 71.00 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.10 20.21 75.16 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.05.01 20.38 76.24 <td>2022.02.09</td> <td>21.29</td> <td>71.00</td>	2022.02.09	21.29	71.00
2022.02.23 18.96 71.09 2022.03.01 18.66 72.13 2022.03.08 18.32 71.11 2022.03.08 18.32 71.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.02 20.26 76.49 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.25 20.39 76.88 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75	2022.02.17	19.97	70.00
1000000000000000000000000000000000000	2022.02.23	18.96	71.09
2022.03.08 18.32 71.11 2022.03.16 18.07 70.00 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.06 18.29 73.20 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.40 71.73 2022.04.21 18.40 71.73 2022.05.01 20.21 75.16 2022.05.02 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.05.30 19.93 76.75	2022.03.01	18.66	72.13
2022.03.16 10.02 10.02 2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.25 20.39 76.53 2022.05.25 20.39 76.75 2022.05.30 19.93 76.75	2022.03.08	18.32	71.11
2022.03.22 17.99 71.00 2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.26 20.39 76.75 2022.05.30 19.93 76.75	2022.03.16	18.07	70.00
2022.03.25 18.22 72.41 2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.02 20.26 76.49 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.25 20.35 76.53 2022.05.25 20.39 76.75 2022.05.30 19.93 76.75	2022.03.22	17.99	71.00
2022.04.01 18.23 74.00 2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75	2022.03.25	18.22	72.41
2022.04.06 18.29 73.98 2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.30 19.93 76.75 2022.05.30 19.93 76.24	2022.04.01	18.23	74.00
2022.04.10 17.95 73.20 2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.12 20.27 76.46 2022.05.20 20.35 76.53 2022.05.20 20.35 76.53 2022.05.30 19.93 76.75	2022.04.06	18.29	73.98
2022.04.15 18.30 71.60 2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.12 20.21 76.46 2022.05.12 20.27 76.46 2022.05.20 20.35 76.53 2022.05.20 20.35 76.53 2022.05.20 19.93 76.75 2022.05.30 19.93 76.24	2022.04.10	17.95	73.20
2022.04.21 18.40 71.73 2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.05.01 20.38 76.24	2022.04.15	18.30	71.60
2022.04.27 19.75 71.90 2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.05.01 20.38 76.24	2022.04.21	18.40	71.73
2022.05.01 20.21 75.16 2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.04.27	19.75	71.90
2022.05.06 20.26 76.49 2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.01	20.21	75.16
2022.05.10 20.14 76.04 2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.06	20.26	76.49
2022.05.12 20.27 76.46 2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.10	20.14	76.04
2022.05.15 20.98 77.12 2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.12	20.27	76.46
2022.05.20 20.35 76.53 2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.15	20.98	77.12
2022.05.25 20.39 76.88 2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.20	20.35	76.53
2022.05.30 19.93 76.75 2022.06.01 20.38 76.24	2022.05.25	20.39	76.88
2022.06.01 20.38 76.24	2022.05.30	19.93	76.75
	2022.06.01	20.38	76.24



2.3 Questionnaire

2.3.1 Questionnaire design

A total of 91 valid questionnaires were collected by publishing questionnaires on the Internet (software Questionnaire Star). The basic situation of the respondents is that nearly 27 percent of them are from the Shanghai area and 18 percent are from Jiangxi Province. The purpose of this questionnaire survey is to determine whether the price changes of pork will affect the price of its substitute beef, so as to verify the importance of stable pork price for the steady development of China's agricultural economy.

2.3.2 Questionnaire results

We can clearly see from the questionnaire that the number of people who are willing to buy pork at a high price accounts for 50.55%. Among the 46 people, 32 people say they are willing to buy beef when the price is high, and the remaining 14 people say they will buy beef only when the price is medium. When the price of pork is at the medium level, 46.15% of the people will buy it. Among them, 9 people say they are willing to buy it when the price of beef is high, 31 people say they will buy it only when the price of beef is at the medium level, and a very small number of 2 people will buy it only when the price is extremely low. Some 3.3 percent said they would buy pork when the price fell, and the number was divided evenly between the three levels of beef prices.

2.4 Analysis

2.4.1 Contingency analysis of pork price and beef price: an independent test

Based on the questionnaire results collected above, the following is a contingency analysis to investigate whether pork prices and beef prices are independent.

Table 2 Contingency table of pork and beef prices							
D (Pork					
Beel	Low price	Medium price	High price	Total			
Low price	1	2	0	3			
Medium price	1	31	14	46			
High price	1	9	32	42			
Total	3	42	46	91			

(1) The contingency table was designed as follows: (significance level α =0.05)

(2)	Based of	on the	above	observa	ations,	hypothesis	testing	is	proposed
-----	----------	--------	-------	---------	---------	------------	---------	----	----------

 H_0 ; $U_1=U_2$ Pork and beef prices are independent of each other

 H_1 ; $U_1 \neq U_2$ Pork and beef prices are not independent of each other

(3) Then we can calculate the degrees of freedom according to the formula:

df=(row number -1)*(column number -1)=2*2=4 (1)

The statistical scale is listed according to the theoretical frequency

 $e = n_i * n_i / n$ (2)

Table 3 Statistical table of pork price and beef price

Beef		T (1		
	Low price	Medium price	High price	Total
Low price	0.10	1.38	1.52	
Medium price	1.52	21.23	23.25	
High price	1.38	19.38	21.23	
Total				91

$$x^2 = \sum_{i=1}^{\infty} \sum_{j=1}^{\infty} \frac{(f_{ij} - e_{ij})^2}{e_{ij}} \sim x^2(\mathrm{df})$$

Calculate chi-square statistics according to the statistical scale and contingency table listed above. The formula is as follows:

Where, i is the number of rows, namely the i th row, j is the number of columns, namely the j th column, and f_{ij} represents the value in the contingency table. e_{ij} represents the corresponding value in the statistical scale. Finally, it is calculated $x^2 = 29.377$ and then combines the significance level α =0.05 getting $x_{0.05}^2(4) = 9.487729037$.

(5) Conclusion: $x^2 = 29.377 > x^2_{0.05}(4) = 9.487729037$

 \therefore Therefore, it can be concluded that the rejection of H_0 means that there is a difference between pork prices and beef prices, that is to say, pork prices and beef prices are not independent of each other.

2.4.2 Analysis of variance of pork and beef prices

(4)

The Analysis of Variance (ANOVA), also known as the "variance analysis" or the "F-test", was developed by Sir Ronald Fisher to test the significance of differences between the means of two or more samples(Statistics Group, Institute of Mathematics, CAS, 1977)^[1]. Analysis of variance can be divided into univariate analysis of variance and multivariate analysis of variance.

In order to explore whether the acceptable price of pork will also affect the acceptable price of beef, we set up a one-way analysis of variance, that is, among the people who accept different prices of pork, we gradually analyze whether the acceptable price of beef is related to the price of pork at a certain price (namely high, medium and low prices).

(1) First, hypothesis testing is proposed:

 $H_0: U_1 = U_2 = U_3$ There is no significant difference between the acceptable price of pork and the acceptable price of beef $H_1: U_1 \neq U_2 \neq U_3$ There is a significant difference between the acceptable price of pork and the acceptable price of beef

			· · · · · · · · · · · · · · · · · · ·			
	Group	Number of observati ons	Sum	Average	Variance	-
	Low price	3	3	1	0	-
	Medium price	3	42	14	229	
	High price	3	46	15.33333	257.3333	_
			Variance analysis			
Source of difference	SS	df	MS	F	P-value	F crit
Between groups	376.2222	2	188.1111	1.160384	0.0374942	5.143253
Within group	972.6667	6	162.1111			
Total	1348.889	8				

Table 4 Variance analysis of pork prices and beef prices.

(2) Selection of test statistics: The test statistic used in ANOVA is F-statistic, namely F-value test.

(3) Calculate the observed values and probability P-values of the test statistics

As can be seen from the results of the one-way ANOVA table in Table 7, the difference of pork price (control variable) on the one-way ANOVA of beef price, because the F value of its variance test is 1.160384, the associated probability is 0.0374942.

(4) Make decisions based on significance level

: P-value= $0.0374942 < \alpha = 0.05$,

That is, the concomitant probability is less than 0.05 of the significance level,

.: rejected the null hypothesis, that is to say, people can accept pork prices high and low for people to accept the price of beef has significant differences, namely in different price of pork, under a certain price (i.e., high, medium and low three level), in which people can accept the price of beef and pork prices.

2.4.3 Regression analysis of pork and beef prices

According to the 31 groups of data from China Pig Breeding Network and Price Trend network shown in Table 1, combined with the monthly wholesale price data (RMB/kg) from December 2021 to May 2022, the Excel software was used to design the independent variable X with pork price (RMB/kg). Regression analysis with beef price (RMB/kg) as dependent variable Y.

For two variables with a linear relationship, we can use a linear equation to express the relationship between them, namely:

$$y = \beta_0 + \beta_1 x + \varepsilon \quad (4)$$

In a unary linear regression model, y is a linear function of x, $(\beta_0 + \beta_1 x)$ plus the error term ε . $\beta_0 + \beta_1 x$ reflects the linear change of y caused by the change of x; ε is a random variable called the error term, which reflects the influence of random factors other than the linear relationship between x and y on y, and is a variability that cannot be explained by the linear relationship between x and y on y, and is a variability that cannot be explained by the linear relationship between x and y. The β_0 and β_1 in the equation are called the model parameters. According to the assumption in the regression model, $\varepsilon=0$, so $y=\beta_0 + \beta_1 x$, where β_0 is the intercept of the regression line on the Y-axis, β_1 is the slope of the line, which represents the average change in y for every change in x by one unit.

The analysis results of Excel are shown in the following table:

Table 5 Coefficients of pork prices and beef prices.

	Coefficients	Standard error	t Stat	P-value	Lower 95%	Upper 95%	Lower limit 95.0%	Upper limit 95.0%
Intercept	55.32591	9.002298	6.145754	0.00000107	36.91415	73.73768	36.91415	73.73768
Pork price (RMB/kg)	0.956499	0.442817	2.160032	0.039173	0.050837	1.862162	0.050837	1.862162

The data in Table 10 can confirm the value of $y = \beta_0 + \beta_1 x$ that the value of β_0 is 55.32591 and the value of β_1 is 0.956499. Therefore, the linear regression equation can be written as:

 $\gamma = 55.32591 + 0.956499\chi$ (5)

(i.e. beef price =55.32591+0.956499* pork price)

This indicates that for every unit increase in pork price, beef price will correspondingly increase by 0.956499 units.

2.4.4 Coefficient of determination R²

The decision coefficient is a measure of the goodness of fit of the estimated regression equation. To illustrate its meaning, it is necessary to study the variation of the value of the dependent variable y.

The value of the dependent variable y is different, and this fluctuation in y value is called variation. The variation comes from two aspects: one is caused by the different values of independent variables; The other is the influence of other factors besides x (such as the nonlinear influence of x on y, measurement error, etc.). For a specific observation, the magnitude of the variation can be expressed as the difference between the actual observation y and its mean \hat{y} which is $(y-\hat{y})$ to show. And the total variation of n observations can be expressed by the sum of squares of these deviations, called the total sum of squares, denoted as SST(Chao huang, Huiqun Gong, 2006)^[2]., i.e:

$$SST = \sum (y_i - \overline{y})^2 \quad (6)$$

And total sum of squares (SST) = regression sum of squares (SSR) + residual sum of squares (SSE). And SSR= $\sum (\hat{y_i} - \bar{y})^2$, SSE= $\sum (y_i - \hat{y_i})^2$. The quality of regression line fitting depends on the size of SSR and SSE, or depends on the ratio of regression square and SSR to the total square and SST (SSR/SST). The closer each observation point is to the straight line, the larger SSR/SST will be and the better the straight line fitting will be. The ratio of the regression sum of squares to the total sum of squares is called the coefficient of determination R^2 and its calculation formula is:

$$R^{2} = \frac{SSR}{SST} = \frac{\sum (\hat{y}_{i} - \overline{y})^{2}}{\sum (y_{i} - \hat{y}_{i})^{2}} = 1 - \frac{\sum (y_{i} - \hat{y}_{i})^{2}}{\sum (\hat{y}_{i} - \overline{y})^{2}}$$
(7)

With pork price as the independent variable and beef price as the dependent variable, the linear regression analysis is conducted. As shown in Table 6, $R^2=0.372277$, r=0.13859.

The results show that the fitting degree between the line and the observation point is relatively general, which means that the change of pork price can explain 13.895% of the change of beef price.

2.4.5 Test of linear relationship

The test of linear relationship is to test whether the linear relationship between the independent variable x and the dependent variable y is significant, or whether they can be represented by a linear model $y=\beta_0 + \beta_1 x + \varepsilon$. In order to test whether the linear relationship between the two variables is significant, it is necessary to construct statistics for testing, and the construction of the statistics is based on the sum of regression squares (SSR) and the sum of residual squares (SSE). The result of dividing SSR by its corresponding degree of freedom (the degree of freedom of SSR is the number of independent variables k, and the degree of freedom in unitary linear regression is 1) is called mean square regression and denoted as MSR. The result of dividing SSE by its corresponding degrees of freedom (degrees of freedom are n-k-1 for SSE and n-2 for unitary linear regression) is called the mean-square residual and denoted as MSE (Junping Jia, Xiaoqun He, Yongjin Jin, 2021)^[3].

Step 1: Make assumptions.

 H_0 ; $\beta_1=0$ The linear relationship between pork price and beef price variables is not significant

Step 2: Calculate the test statistic F.

$$F = \frac{SSR/1}{SSE/(n-2)} = \frac{MSR}{MSE} = 4.66574$$
(8)

Step 3: Make a decision.

According to the significance level α =0.05, molecular degree of freedom $df_1 = 1$ and denominator degree of freedom $df_2 = 31 - 2 = 29$. Check the F distribution table and find the corresponding critical value. Because F=4.66574>F_{\alpha} = 4.28, reject H_0 , indicating that the linear relationship between pork price and beef price variables is significant.

3. Conclusion

This paper collected 31 groups of data from China Pig Breeding Network and Price Trend Network, combined with monthly wholesale price data (RMB/kg) from December 2021 to May 2022 for a total of six months, and released and collected 91 online questionnaires to empirically test the relationship between pork prices and beef prices. The results show that, first, there are differences between pork prices and beef prices, that is, pork prices and beef prices are not independent of each other, and they affect each other. Second, among people who accept pork at different prices, the price of beef that people can accept is related to the price of pork at a specific price (i.e. high, medium and low prices). Third, there is a weak positive correlation between pork price and beef price, that is, the rise of pork price will lead to the further rise of beef price. If the price of pork is always at a high level, China's agricultural economy will be greatly impacted and traumatized, and may even lead to inflation with a high risk factor. Therefore, controlling the stability of pork prices is crucial to China's economy.

In recent years, with the rapid development of China's economy and the rapid improvement of pig breeding level, China has become a world recognized pig breeding country. At present, the breeding varieties of pigs in China are gradually enriched, and the investment in science and technology is gradually increasing, which has also attracted more and more foreign venture capital companies to engage in the pig industry (Wenyan Xiu, 2010)^[4]. However, in recent years, due to the outbreaks of mad cow disease, swine avian influenza, foot and mouth disease, and the improper use of antibiotics in feed, consumers expressed concern about the

quality and safety of livestock products. Therefore, according to the biological characteristics of pigs, we should use scientific knowledge to raise pigs, provide welfare guarantee for pig growth, and implement healthy pig breeding (Lang Qiao, Xinyu Guo, Cheng Peng, 2019)^[5].

The following policy recommendations are made to stabilize pork prices. Take various measures to ensure the continuous and stable growth of pig supply, reduce pig breeding costs, improve pig breeding methods, and enhance production capacity (Yuhong Sun, 2014)^[6]; Establish a price warning mechanism between pork and pigs, corn and piglets, publish pork market information in real time, and strengthen the information guidance of the pork industry; Pay close attention to changes in demand factors such as residents' consumption level, beef price and chicken price, and actively adjust the abnormal pork price caused by changes in demand factors (Liyu Zhu, Chunyan Feng, Luling Shen, 2020)^[7].

References

[1] Statistics Group, Institute of Mathematics, CAS. (1977) Analysis of Variance: Science Press.

[2] Chao H, Gong HQ.(2006) Time series linear regression based on decision coefficient and trend change. Statistics and Decision Making. no.24, pp.23-24.

[3] Jia JP, He XQ, Jin YJ.(2021) Statistics, Beijing: China Renmin University Press.

[4] Xiu WY. (2010). Research on Pork Quality and Safety in China (Ph. D. dissertation, Chinese Academy of Agricultural Sciences).

[5] Qiao L, Guo XY, Peng C.(2019). Analysis on the causes of pork price fluctuation based on multidimensional association rules. Jiangsu Agricultural Sciences no.11, pp. 332-335.

[6] Sun YH.(2014). Analysis on the importance and Existing problems of healthy pig breeding. Chinese Animal Husbandry and Veterinary Abstracts no.08, pp.31.

[7] Zhu LY, Feng CY, Shen LL.(2020). Analysis on the price correlation of pork and its substitutes under the impact of dual epidemic situation. Rural Economy and Science and Technology no.23, pp.86-89.